Difficulties arising when PS-InSAR displacement measurements are compared to results from geomechanical and groundwater flow computations.

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Land subsidence is a major challenge for cities situated on compressible sediments with high population densities, undergoing rapid development. Exploitation of groundwater is often cited as the main cause of subsidence, as it can lead to a decrease in water pressure in the saturated geological medium, resulting in consolidation processes[1].

Interferometric Synthetic Aperture Radar (InSAR) technology has been used to detect the location and magnitude of ground deformation for the past 30 years, providing cost-effective measurements with a fine resolution and precision within centimeters under ideal conditions[2]. Persistent Scatterer InSAR Interferometry (PS-InSAR) is an InSAR algorithm that has been developed to overcome decorrelation due to changes in the physical characteristics of the surface over time that limit the InSAR applications [3,4].

PS-InSAR processing has been used to identify multiple localized land subsidence in the Antwerp and Leuven areas in Belgium. In Antwerp, the harbour was gradually developed, leading to dock excavations in a compressible estuary polders environment and PS-InSAR was used to detect, map and study the ground displacements[5]. In Leuven, significant subsidence was observed through the city and the suburbs, potentially due to delayed consolidation in compressible, low permeability aquitards. One of the possible cause of these subsidence phenomena is related to variation in groundwater levels resulting in consolidation processes. To test this hypothesis, geomechanical calculations coupled to groundwater flow models are carried out to simulate the vertical displacements. The results are compared to PS-InSAR-derived subsidence observations for a better understanding of subsurface consolidation mechanisms.

However, there are several practical and conceptual challenges that must be considered when comparing InSAR measurements to results from hydrogeological and geomechanical models. One issue is the choice of the appropriate modeling scale, as subsidence may occur locally but also regionally as influenced by groundwater pore pressure variations occurring at different scales. Another challenge lies in the selection of the appropriate conceptual assumptions linked to the groundwater flow and geomechanical models. Indeed, in addition, uncertainty in the model parameter values is a typical source of uncertainty in the model results. There may also be errors in the InSAR measurements due to various factors such as atmospheric effects and changes in the surface roughness. All these challenges must be taken into account when comparing InSAR measurements to model results.

In conclusion, comparing InSAR measurements with hydrogeological and geomechanical modeling results can provide valuable insights into the actual mechanisms of subsidence. However, it is important to carefully consider the practical and conceptual challenges and limitations linked to this interesting comparison.

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